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(54) **Improvements in or relating to lines and braids**

(57) Lines comprising dual dissimilar materials are described. One material 10 having relatively high energy absorbing properties such as nylon and the other 11 being of relatively high tensile strength such as paramid. One end of each material is secured to a restraining means 12 such as a parachute and the other end of each material is secured to a store 13. In operation the high energy absorbing material 10 absorbs part of the kinetic energy before the high tensile strength material 11 begins to be stressed.

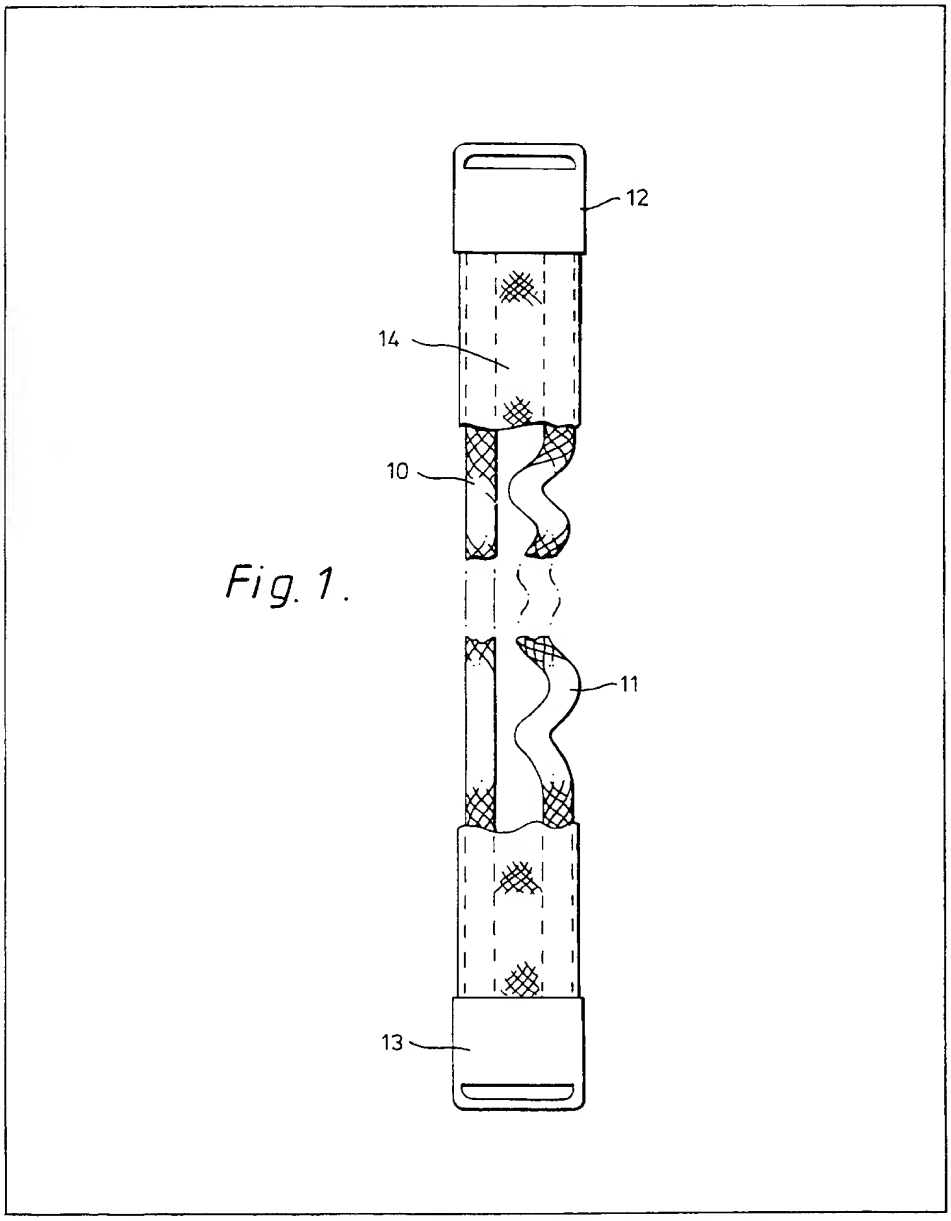

Fig. 1.

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The drawing(s) originally filed were informal and the print here reproduced is taken from a later filed formal copy.

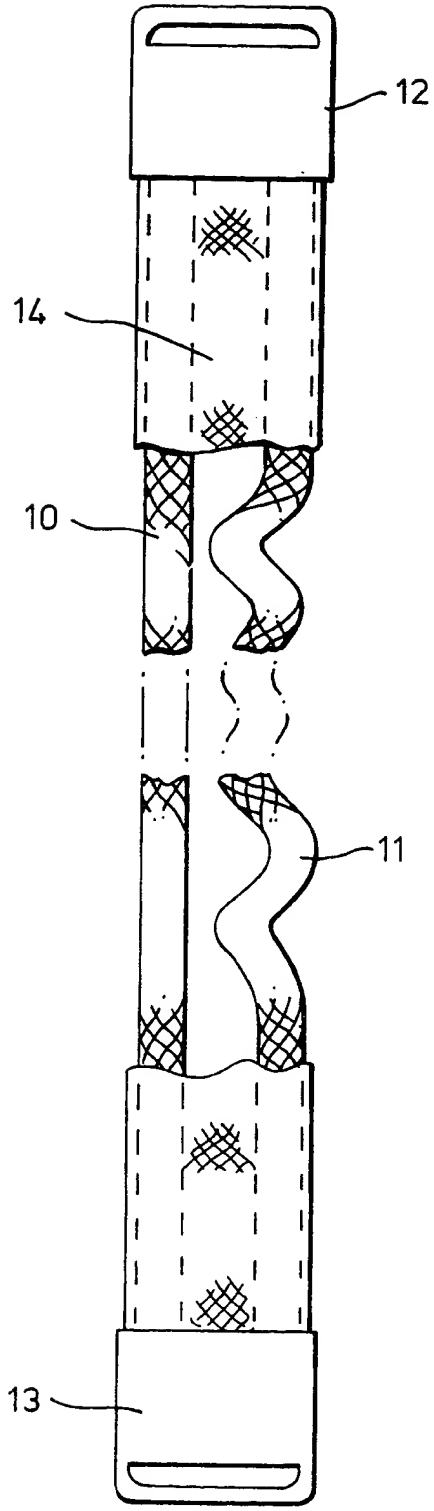

Fig. 1.

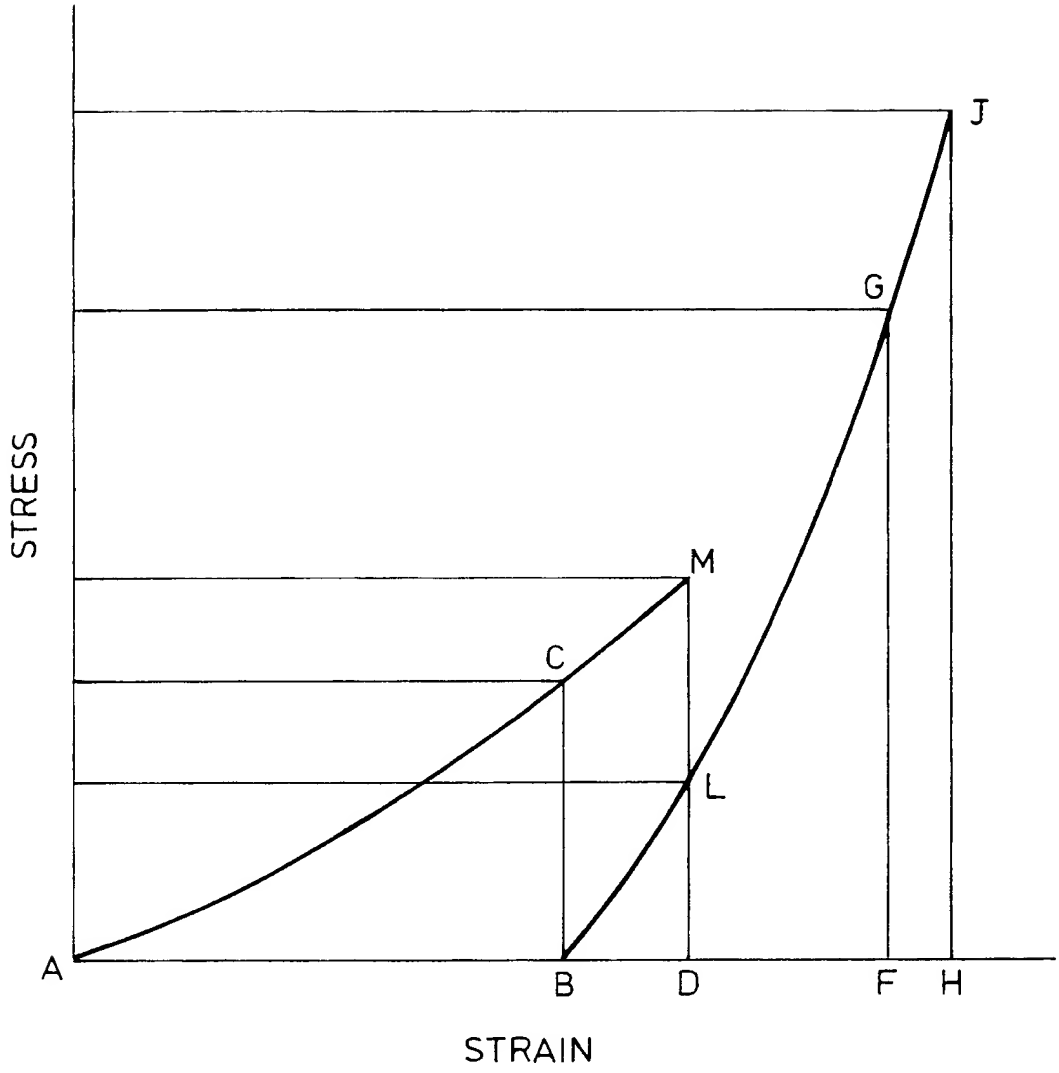

Fig. 2.

SPECIFICATION

Improvements in or relating to lines and braids

The present invention relates to the absorption of kinetic energy and particularly to lines and braids used for this purpose during the suspension of stores from aircraft or parachutes.

The absorption of the kinetic energy of a store on deployment of a parachute for example is achieved by various methods, many involving textiles in tension. The induced loads are often very high and precede subsequent static or drag loads.

In some applications the energy absorber can be reused, as in paratrooping or aircraft-brake parachutes; in others the absorber can be used only once, as in undrawn nylon ropes on aircraft carriers and airfield barriers in arrester gear equipment designed to stop aircraft during emergency landings. Evidently in applications such as the latter the physical bulk of the nylon is of lesser importance since there are less severe storage or weight penalty problems on board large ships or on airfields. This is not so, however, when parachute assemblies are required to absorb large quantities of energy and finally to sustain heavy loads such as for example when used in aircraft ejection seat applications or the dropping of heavy stores from high speeds. In these instances the minimising of bulk and mass of the equipment to be carried on board aircraft is of prime importance.

The introduction in recent years of paramid materials, of which the most common is Kevlar (Regd trade mark) now affords the opportunity of producing ropes and straps capable of bearing higher loads than those sustainable hitherto by a given mass of material such as nylon.

Additionally, the introduction of paramid fibre now allows the production of composite lines and braids comprising the two fibres, nylon and paramid, to take advantage of the known ability of nylon as an energy absorber and the ability of the paramid to sustain high loads.

According to the present invention at least one line is provided between and secured to retraining means at one end and a store at the other end of the line, the line comprising at least two dissimilar materials in parallel, one material having relatiely high energy absorption properties and the other material having relatively high tensile strength, the arrangement being such that in operation the high energy absorbing material absorbs part of the total energy before the high tensile strength material begins to be stressed.

Preferably the high energy absorbing material is nylon and the high tensile material is paramid.

The composite line is preferably constructed such that complete failure of the high energy absorbing material, that is the nylon, will occur in operation and that the failure will occur after the high tensile strength material, that is the paramid, has begun to be stressed. The complete failure of the nylon will ensure lower rebound characteristics of the store, due to lower stored energy, giving a lighter and more stable system and the prestressed paramid at nylon failure will lessen the possibility of paramid failure caused by second impact.

According to a further feature of the present invention the composite line is constructed such that a braid of one material lies inside a braid of the second material.

When constructing a composite line the properties and dimensions of the materials used will be chosen relative to the physical parameters governing the store and the restraining means, for example a parachute, and also the dynamic conditions pertaining at the time of deployment of the store/restraining means system.

In order that the invention may be more fully understood it will be described by way of example only with reference to the following Figures.

Figure 1 - showing a schematic diagram of a composite line used between a parachute and a store, and

Figure 2 - showing a graph depicting the stress/strain behaviour of a composite line.

Referring now to Figure 1. Each end of a nylon braid 10 and a Kevlar braid 11 are secured to parachute and store attachment means 12 and 13 respectively. The Kevlar braid 11 has been formed a predetermined length longer than the nylon braid 10. The two braids are contained within a light textile fabric sheath 14.

Referring now also to Figure 2. On initial deployment of the parachute the nylon braid 10 begins to absorb the kinetic energy and is loaded along the line AC. When the actual strain in the nylon braid reaches AB then the length of the nylon at that point equals the straightened but unstressed length of the Kevlar braid 11. As the nylon braid 10 is further extended along the line CM the Kevlar braid 11 also begins to be stressed along the line BL. At the point M on the stress/strain curve failure of the nylon braid 10 occurs and the total remaining energy, both dynamic and static must be sustained by the Kevlar braid 11 which continues to be loaded along the line LJ.

The area ABC is a measure of the energy absorbed by the nylon up the point where the Kevlar begins to be stressed. (ADM)+(BDL) is the energy absorbed by the two braids at the point of nylon failure. The final static load conditions will be somewhere along the line LJ, for example point G where all the kinetic energy has been absorbed, the energy absorbed by the Kevlar braid after nylon braid failure corresponding to the area DFGL.

The line parameters are chosen so that in the final loaded condition the Kevlar lies at a point between L and J on the stress/strain curve. If the area bounded by BHJ is displaced to the right of the area ADM then a second impact will occur, that is the nylon braid fails before the Kevlar braid begins to be stressed and may result in failure of the Kevlar braid. If all of the energy is absorbed prior to nylon braid failure, that is the line GF lies to the left of the line MD, then store rebound will occur possibly producing an oscillating, unstable store.

In a modification of the invention a braid of two different materials may be co-woven to form a single line, however, effective control would be needed to

maintain the relative fibre lengths of the two materials in the correct proportions.

A further application of the inventive concept would be in the deployment and suspension of heavy loads from aircraft such as helicopters.

For the purpose of this patent specification the words line and braid can also mean cord, rope, flat webbing, straps etc.

The invention could also be achieved by the use of suitable materials other than nylon and Kevlar.

CLAIMS (Filed on 24th Nov, '82)

1. A line for the absorption of kinetic energy, the line comprising at least two dissimilar materials in parallel, one material having relatively high energy absorbing properties and the other material having relatively high tensile strength, the arrangement of the two materials being such that in operation the high energy absorbing material absorbs part of the total energy before the high tensile strength material begins to be stressed.

2. A line according to claim 1 and wherein the high energy absorbing material is nylon and the high tensile strength material is paramid.

3. A line according to claim 1 or claim 2 and wherein the arrangement and construction of the line is such that in operation failure of the high energy absorbing material occurs after the high strength material has begun to be stressed, the high strength material absorbing the residual kinetic energy.

4. A line according to any one of the preceding claims and wherein the line is constructed such that a braid of one material lies inside a braid of the second material.

5. A line according to any one of the preceding claims and wherein the line is secured at one end to a restraining means and at the other end to a store.

6. A line according to claim 5 and wherein the restraining means comprises at least one parachute.

7. A line substantially as hereinebefore described with reference to the specification and accompanying drawings.

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